Vol. 95. Part 1. Pp. 1–24, 2 maps 30th June, 1945.

IMP. INST. ENT.
— LIBRARY —
15 NOV 19[illegible]
SERIAL Ent. 344
SEPARATE

THE

TRANSACTIONS

OF THE

ROYAL ENTOMOLOGICAL SOCIETY

OF

LONDON

World List abbreviation: *Trans. R. ent. Soc. Lond.*

CONTENTS

PAGE

LEWIS, D. J., M.A., F.R.E.S. Observations on the distribution and taxonomy of CULICIDAE (Diptera) in the Sudan . 1–24, 2 maps

LONDON:
PUBLISHED BY THE SOCIETY AND
SOLD AT ITS ROOMS, 41, QUEEN'S GATE, S.W.7

Price 6s. 0d.

THE ROYAL ENTOMOLOGICAL SOCIETY OF LONDON

Founded, 1833. Incorporated by Royal Charter, 1885.

PATRON—HIS MAJESTY THE KING.

OFFICERS and COUNCIL for the SESSION, 1945–1946.

PROF. G. D. HALE CARPENTER, M.B.E., D.M., *President.*

FRANCIS HEMMING, C.M.G., C.B.E.
O. W. RICHARDS, M.A., D.Sc.
C. B. WILLIAMS, M.A., D.Sc. } *Vice-Presidents.*

A. WELTI, *Treasurer.*

N. D. RILEY, *Secretary.*

Other Members of Council.

E. A. ANDREWS, M.A.
C. H. ANDREWES, F.R.S.
E. A. COCKAYNE, M.A., M.D., F.R.C.P.
J. W. EVANS, M.A., D.Sc.
W. J. HALL, D.Sc.
H. E. HINTON, B.Sc., PH.D.
SIR GUY A. K. MARSHALL, K.C.M.G., D.Sc., F.R.S.
J. F. PERKINS, B.Sc.
MISS E. M. RALFS, B.A.
REV. C. E. TOTTENHAM, M.A.
H. B. WILLIAMS, LL.D.

F. J. GRIFFIN, A.L.A., *Registrar.*

Finance and House Committee.

FRANCIS HEMMING, C.M.G., C.B.E. (Chairman).

R. B. BENSON, M.A.
PROF. H. G. CHAMPION, C.I.E., M.A.
J. W. EVANS, M.A., D.Sc.
W. RAIT-SMITH.
O. W. RICHARDS, M.A., D.Sc.

Publication and Library Committee.

W. J. HALL, D.Sc. (Chairman).

K. G. BLAIR, D.Sc.
H. E. HINTON, B.Sc., PH.D.
B. M. HOBBY, M.A., D.PHIL.
J. F. PERKINS, B.Sc.
C. B. WILLIAMS, M.A., D.Sc.

Committee on Generic Nomenclature.

FRANCIS HEMMING, C.M.G., C.B.E. (Chairman).

W. A. F. BALFOUR-BROWNE, F.R.S.E.
K. G. BLAIR, D.Sc.
O. W. RICHARDS, M.A., D.Sc.
N. D. RILEY (Secretary).

Committee for the Protection of British Insects.

J. C. F. FRYER, O.B.E., M.A. (Chairman).

CAPT. E. BAGWELL-PUREFOY.
R. B. BENSON, M.A.
E. A. COCKAYNE, M.A., M.D., F.R.C.P.
COL. F. A. LABOUCHERE.
N. D. RILEY.
THE HON. MIRIAM ROTHSCHILD.
W. H. THORPE, M.A., Sc.D.
H. M. EDELSTEN (Secretary).

The Executive Officers of the Society are *ex-officio* members of all Committees.

DELEGATES OF THE SOCIETY TO:

1. **British National Committee for Biology** (Royal Society).
   Sir Guy A. K. Marshall, K.C.M.G., D.Sc., F.R.S., appointed 1939.
   Dr. V. B. Wigglesworth, M.A., B.Ch., M.D., F.R.S., appointed 1943.
2. **Local Committee of Management of Wicken Fen.**
   Mr. H. M. Edelsten nominated by Committee for the Protection of British Insects].
3. **National Trust for Places of Historic Interest or Natural Beauty.**
   Mr. H. M. Edelsten, appointed 1944.
4. **New Forest Association.**
   Mr. W. Fassnidge, appointed 1934.
5. **New Forest Joint Committee.**
   Mr. W. Fassnidge, appointed 1939. *Dr. F. J. Killington, appointed 1939.*
6. **Royal Meteorological Society. Phenological Committee.**
   Dr. C. B. Williams, appointed 1937.
7. **Biology War Committee.**
   Prof. P. A. Buxton, F.R.S., appointed 1941.
8. **Council for the Promotion of Field Studies.**
   Dr. W. H. Thorpe, M.A., Sc.D., appointed 1944.

TRANSACTIONS

OF THE

ROYAL

ENTOMOLOGICAL SOCIETY

OF LONDON

VOL. 95. 1945.

OBSERVATIONS ON THE DISTRIBUTION AND TAXONOMY OF CULICIDAE (DIPTERA) IN THE SUDAN

By D. J. LEWIS, M.A., F.R.E.S.

(*Entomologist, Stack Medical Research Laboratories, Khartoum.*)

Manuscript received 8 July, 1944.

(Read 1 November, 1944.)

THE object of this paper is to bring up to date our knowledge of the taxonomy and general distribution of mosquitoes in the Anglo-Egyptian Sudan, and thus to facilitate their identification in that country. Nearly all our knowledge on taxonomy is to be found in *Mosquitoes of the Ethiopian Region* by Hopkins (1938), Evans (1938), Edwards (1941) and in notes and corrections by Hopkins (1941).

The Anglo-Egyptian Sudan lies entirely within the Tropics and, with the exception of an area of desert in the north-west, forms a large section of the north-eastern part of the Ethiopian Zoogeographical Region. Certain species have evidently at some period spread into the country from the north and north-east. Most of the remainder occupy the southern third of the country but many disappear as one approaches or reaches the desert in the central third. In this area most records refer to the rainy season. Several species show wide gaps in their distribution and it seems probable that they were more widely distributed in the past when the climate was less arid. Brief reference is made to some examples by Lewis (1944b).

One of these gaps is of particular interest. In his discussion of the zoogeography of Ethiopian mosquitoes Edwards (1941) wrote that the fauna of the Somali arid district might well be regarded as an extension southward of the Mediterranean fauna via the Red Sea. Several species, including *C. sinaiticus* and *C. laticinctus* (both now known somewhat farther west in the Sudan), owed their inclusion in Ethiopian lists to their occurrence in this area. Edwards expected that other Mediterranean mosquitoes might eventually be found in the Somali arid district. Recently Dr. P. Abbott has obtained *Theobaldia longiareolata*, *Culex arbieeni* (previously known only in Sinai),

C. sinaiticus and *C. laticinctus* in western Darfur some 1600 kilometres from the Red Sea. *C. pipiens* also occurs there as well as the East African highland species *Aëdes quasiunivittatus* (Edwards 1941), and *Anopheles cinereus* which Abbott has also found. Balfour-Browne's remarks (1943) on the zoogeography of the Jebel Marra massif are of particular interest in relation to the finding of *C. arbieeni* and the other species in the area. He refers to Good's work on the flora and writes that " it would be expected that the Apionine fauna would show a distinct Egypto-Syrian element."

During the identification of mosquitoes abnormal appearances are sometimes seen which are apparently not due to variation. The divisions of the phallosome of some males of *Culex fatigans* and a male of *C. simpsoni* were observed to be out of position, as in the male of *C. theileri* described by Salem (1940). In the case of *C. fatigans* the displacement was apparently due to the terminalia being cut off immediately after death with an insufficiently sharp needle. In a few larvae of *Ficalbia lacustris*, *C. poicilipes* and *C. sinaiticus* the antenna of one side was reduced to a rounded stump, possibly owing to injury.

Species Known at Present.

Edwards (*loc. cit.* : 469) gives the names of 101 species, one subspecies and five varieties of mosquitoes from the Anglo-Egyptian Sudan. The occurrence of *Aëdes dentatus* has been confirmed by examination of the male terminalia, but two species must be omitted from the list, *Uranotaenia coeruleocephala* and *Aëdes dentatus*, the occurrence of which has not been verified. The locality given by Edwards for *Aëdes albothorax* is no longer in the Sudan but this species has since been found inside the country. Thirty-one additional forms of Culicidae have been recorded and the known total is now 136, comprising 127 species, 3 subspecies and 6 varieties; the Chaoborini number two forms, the Anophelini 26, the Megarhinini two and the Culicini 106. The number of species of Culicidae is about a third of the number known in the Ethiopian Region. The additional forms are as follows.

Chaoborus (*Sayomyia*) *pallidipes* Theobald
,, ,, *ceratopogones* Theobald.
Anopheles (*Anopheles*) *coustani* Laveran
,, ,, *symesi* Edwards
,, ,, *obscurus* Grünberg
,, (*Myzomyia*) *rivulorum* Leeson
,, ,, *leesoni* Evans *
,, ,, *macmahoni* Evans
,, ,, *cinereus* Theobald *
,, ,, *rufipes* var. *ingrami* Edwards
,, ,, *maculipalpis* Giles
Megarhinus viridibasis Edwards
Uranotaenia alba Theobald *
,, *candidipes* Edwards *
Aëdes (*Stegomyia*) *africanus* Theobald
,, (*Aëdimorphus*) *stokesi* Evans *
Aëdes (*Aëdimorphus*) *leesoni* subsp. *verna* Lewis
,, (*Banksinella*) *lineatopennis* Ludlow
,, ,, *palpalis* Newstead
,, (*Diceromyia*) *taylori* Edwards
Eretmopodites chrysogaster Graham
,, *quinquevittatus* Theobald
Culex (*Neoculex*) *arbieeni* Salem *
,, (*Culiciomyia*) *cinereus* Theobald
,, ,, *macfiei* Edwards
,, (*Culex*) sp. (allied to *tritaeniorhynchus*?) *
,, ,, *theileri* Theobald
,, *pipiens* subsp. *molestus* Forskål
,, ,, *guiarti* Blanchard *
,, ,, *weschei* Edwards
,, ,, *ingrami* Edwards

* Identified from larvae only.

In addition to these species mention may be made of *Culex andersoni* subsp. *abyssinicus* Edwards which was found at Khartoum in an aircraft from Asmara (20.iii.40) and in one from Addis Ababa (ii.v.40).

Notes on the Taxonomy and Distribution of Certain Species.

The mosquitoes considered below comprise those on which taxonomic observations have been made and those the known distribution of which has been extended farther than that recorded in *Mosquitoes of the Ethiopian Region*. Only additional localities are recorded. In localities for which the collector's name is not given nearly all the specimens were collected by the author. Places are shown in map 1.

It is intended to send specimens of newly described forms to the British Museum (Natural History).

Chaoborus ceratopogones Theobald.

The known African species of *Chaoborus* have been described by Edwards (1930).

Distribution.—Malakal, Tonga, Kosti, Abu Hagar, Umm Sunt, Wad El Magdub and Hawata.

Chaoborus pallidipes Theobald.

Distribution.—El Amira (xii.40).

Anopheles coustani Laveran.

A variation described by Evans, in which the third hind tarsal segment is entirely pale, has been seen in specimens from Meridi, Yei, Akobo, Torit, Wad Subahi, Sennar, Wad El Magdub and Khartoum.

Distribution.—Meridi (*W. Ruttledge*); Yei (*H. Greene*); Akobo (*L. H. Henderson*); Talodi (*J. W. Cowland*); Shambat (*W. P. L. Cameron*); Umm Berembeita (*M. S. En Nur*); Yubo, Torit, Buffalo Cape, Heiban, Sennar, Wad Subahi, Umm Sunt, Wad Medani, Wad El Magdub, Khartoum and Gereif.

Anopheles coustani var. *ziemanni* Laveran.

Distribution.—This mosquito occurs in most parts of the Sudd region and is often the commonest Anopheline. Between Jebelein and Geteina it is replaced, as the principal swamp-breeding Anopheline, by *A. pharoensis*. For brevity all records of localities on the Nile between Shambe and Jebelein and on the R. Zeraf are omitted. Other localities are: Lado (*Greene*); Yubo, Dingba, Keilak, Heiban, Rahad, Kosti, Aba Island, Jebel Bereima, Ez Zuleit, Shawal, Kereida, Roseires, Tertera, Seregaya, Suelik, Sennar, Wad Medani, Wad El Magdub, Abu Usher and Khartoum. Many records of larvae from Equatoria probably refer to this variety.

Anopheles symesi Edwards.

Distribution.—Lake Jur.

Anopheles obscurus Grünberg.

Distribution.—Yei (25.vii.33, *Ruttledge*).

Anopheles nili Theobald.

Distribution.—Wau (*S. M. Burrows*); Juba, Lake No, Lul, Ez Zuleit, Shabak, Jebelein and Kosti.

Anopheles funestus Giles.

Distribution.—Common in many parts of the southern Sudan and along the White Nile as far north as Jebelein. Its known distribution in the eastern part of the central Sudan, with that of the very similar species *A. rivulorum* and *A. macmahoni*, is shown in map 2. The other similar species known to occur in the Sudan is *A. leesoni*. *A. funestus* has never been found to be abundant on the White and Blue Niles north of Jebelein and Sennar respectively. A specimen has been found at Khartoum in an aeroplane from South Africa (Whitfield, 1939).

Anopheles rivulorum Leeson.

De Meillon and Pereira (1940), after examining a large number of specimens resembling *A. rivulorum*, from Portuguese East Africa, concluded that it was probably a very variable species and that *A. r. garnhamellus* might be merely an individual variation of the type. They stated that to settle the status of *A. rivulorum* and its ally it would be necessary to examine large collections of adults with their associated pelts from different parts of the Ethiopian Region. A few specimens from the Sudan have been examined and their characters are of some interest. They were obtained at Hawata (4.xii.42) and Danagla (17.x.43).

The wings of 17 adults, the larval pelts of which were identified, were examined. A dark preaccessory spot was present in all except one female. When present it varied considerably in size and was occasionally, especially in males, reduced to two or three scales. In one male it was present on one wing and not the other. In every case the base of the costa was dark and there was no sub-median pale area on vein 5·1.

In 17 larval pelts which were examined the number of accessory plaques on abdominal segments III to VII varied from three on each segment to one on each, except VII, which had two. In most of the pelts there were three accessory plaques on III to VII. The central plaque was always present but one or both of the lateral plaques might be absent.

It appears that in the central Sudan the dark preaccessory spot is of considerable value in distinguishing *A. rivulorum* from *A. funestus* which usually lacks it. Evidently, however, individuals can only be definitely identified by examining the larvae or the post-armature ridges of the female.

Distribution.—*A. rivulorum* has been found on the rivers Blue Nile, Rahad and Atbara, the localities being shown in map 2. On the Blue Nile larvae were found in grassy swamps, and on the Atbara among pebbles. On the Rahad they were found among pebbles and among sedge along the margin of the river at low water.

Anopheles leesoni Evans.

One larva, apparently of this species, has been obtained. No longitudinal dark bands are present on the anterior half of the fronto-clypeus.

Distribution.—Niertete (at base of J. Marra, 5.ii.44, *Abbott*).

Anopheles wellcomei Theobald.

Distribution.—There are many records from places on the Nile between Shambe and Jebelein and on the R. Zeraf. This species is particularly abundant at Lake No. Other localities are: Wau (*Burrows*); Shukoli (*Ruttledge*); Yubo, Mvolo, Bor, Kosti, Ez Zuleit, Rahad, Kereida, Seregaya, Abu Hagar, Wad Medani and Wad El Magdub.

Anopheles dthali Patton.

Distribution.—Erkowit (larvae abundant in stream in dry season).

Anopheles rupicolus Lewis.

A female from Keteri is much darker than specimens from the north.

Distribution.—Keteri (*N. el Hude*); Tokar (*F. J. Hoare*); Erkowit (*E. Jane*); Talodi, Heiban, Dunger, Tiger, Umm Dorein, Chunger, Tagoi and Agur.

Anopheles macmahoni Evans.

Distribution.—Nuba Mountains (map 2).

Anopheles gambiae Giles.

Females with four pale bands on the palps have been found at Heiban and Sennar.

Distribution.—Many localities on the Nile from the Uganda border to the Egyptian border. This species is widely distributed in the southern and central Sudan. West of the White Nile it extends about as far north as the 14th parallel. On the east side it has been found as far north as Erkowit (*Ruttledge*), where it is uncommon, and in a train arriving at Port Sudan (*J. Edwards*). Observations on the distribution of *A. gambiae* near the Egyptian border were made by Lewis (1942a, 1944b).

In this connection it is of interest to note that although Evans (1938) stated that the most northerly record in the Nile Valley was from Zeidab, *A. gambiae* had been recorded from farther north. Balfour (1908) wrote that during the winter of 1906 to 1907 this species was found breeding in the river bed in the (now non-existent) Dongola Province. The boundary of this Province crossed the Nile some 420 kilometres downstream from Zeidab and it is probable that the *A. gambiae* was found over 100 kilometres farther down. *A. gambiae* was found at Merowe near this point in 1938 (i–iii, *A. H. Hussin*).

Anopheles cinereus Theobald.

Distribution.—Jebel Marra : 6000 ft. and 7000 ft. at Koronga, ii.44 (*Abbott*).

Anopheles multicolor Camb.

Distribution.—Faras.

Anopheles rufipes Gough.

Three females from Rahad show variation of the palpal markings. In one the tip is grey and in two it is black. In two males from the same place the club is dark except for the distal pale patch. The hind tarsal markings are variable. Some specimens from Kosti show a variation described by Evans, a dark band on the third joint only about a quarter or a third of its length with sometimes a basal white ring. Other specimens show a black band on the fourth joint. On the terminal joint a grey or black band, sometimes exceeding half its length, is often seen.

On vein 1 of the wing in specimens from several places the subapical pale interruption of the second main dark area is joined to the subcostal spot.

Distribution.—Many localities on the White Nile from Jebelein to Jebel Auliya. Also from : Torit (*R. W. Stephenson*); Meridi and Jebel Meidob

(*R. C. Maxwell-Darling*); Li Rangu (*H. M. Woodman*); Kadugli, Umm Berembeita and Goz Khadra (*Ruttledge*); Kalokitting (*Abbott*); Bara (*K. Babikr*); Yubo, Paraconda, Talodi, Agur, Heiban, Koma, Chunger, El Amira, Umm Dorein, Rahad, Kauda, Kinderma, Kologi, Kodi, Masakin, Abri, Umm Jan, Lake No, mouth of R. Zeraf, Malakal, Keri Kera, Abu Hagar, Sennar, Wad Medani and Hawata; Khartoum (*H. W. Bedford*).

Anopheles rufipes var. *ingrami* Edwards.

Distribution.—Koma (female with tip of palpi dark), El Amira and Heiban (female with narrow dark basal ring on third hind tarsal segment).

Anopheles pretoriensis Theobald.

Some females from Heiban show the four-banded condition of the palps described by Evans, the terminal band varying in length. In one specimen there are three pale bands and the tip is dark.

Distribution.—Umm Dona and Zalataya (*Ruttledge*); Talodi (*Cowland*); Kadugli (*Salaam*); Niertete, Zalingei and Nambia (*Abbott*); Kassala and Galabat (*M. M. Hassan*); Basunda (*El Huda*); Heiban, Kauda, Kodi, Umm Jan, Tagoi, El Fasher, Wad Medani (rare), Wad Arud and Sofi.

Anopheles maculipalpis Giles.

Distribution.—Kauda (18.xi.40); Yubo (*S. Abdel Razig*).

Anopheles pharoensis Theobald.

Distribution.—There are hundreds of records from the southern and central Sudan where the species is widely distributed. It is common all along the Blue and White Niles in the rainy season. On the main Nile it has been found at Kadaro (*G. A. Glass*) and once at Zeidab (*H. H. King*, 1913). Other northerly localities are: Abu Kidada and Er Ruat (*Ruttledge*); Wadi Kaja (*Abbott*); Keilak, El Amira, Rahad, Hawata and Faras. *A. pharoensis* is the commonest Anopheline in the Jebel Auliya and Sennar Reservoirs.

Anopheles squamosus Theobald.

Distribution.—Wau (*H. D. Fairman*); Akobo (*Henderson*); Umm Berembeita and Abu Kidada (*Ruttledge*); Talodi (*Cowland*); Juba, Paraconda, Lake No, Fanjak, Malakal, Panamtin, Tiptiap, Ez Zuleit, Dibeiba, Jebelein, Umm Jan, Heiban, Rahad, Kosti, Bakht er Ruda, Riad, Jebel Auliya, Umm Shoka, Jebel Dud, Sennar, Wad el Magdub, Hawata, Soba and Khartoum.

Megarhinus brevipalpis subsp. *conradti* Grünberg.

Distribution.—Li Rangu (*M. H. Nasr*); Lui (*A. M. Casson*); Lotiko (*A. E. Lorenzen*); Heiban (*A. A. Bereir*).

Megarhinus viridibasis Edwards.

The description of the larva below was made from three pelts, two from Wad Medani (viii.41, *R. G. Sheehan*) and one from Heiban (ix.41, *Bereir*). The pupa was described from pelts of the Wad Medani mosquitoes.

Pupa. Resembles that of *M. erythrurus* (described by Edwards, 1941) more than *M. brevipalpis*. It differs from the former as follows. K single or double; L single or with 2–4 branches; M with 5–8 branches; S and T about equal to K.

Larva. *Head.* Almost quadrangular in shape, about as long as broad. Antenna less than half length of head; tuft at 0·8, dendroid; sub-terminal spines at 0·7 on lower surface, each about 0·5 length of antenna. Setae A, B and C slender, distinctly less than 0·5 length of head, A and C simple, B with 2 or 3 branches near its tip, *d* small with dendroid branching; all these setae are just posterior to the base of the antenna and the bases of B, C and *d* are almost in a straight line. Mentum with very coarse teeth, 7 or 8 on each side of the central tooth which is directed ventrally; 2 large teeth lie on each side of the central group of 3. *Thorax.* Mesothoracic setae in order from centre of dorsum outwards: 2 slender setae on minute tubercles; 2 slender setae, the outer one with about three branches from near base, on small plates; dorso-lateral plate bearing a long slender seta, a stout plumose seta and a seta with about 4 branches; lateral plate with a stout plumose seta; a small branched hair on a minute or a small plate; ventro-lateral plate bearing a minute seta, a stout plumose seta and 2 long setae. Metathoracic setae: 2 setae on small plates with three smaller setae on tubercles or plates, anterior to them; stout plumose seta on dorso-lateral plate; stout plumose seta or branched hair on lateral plate; ventro-lateral plate bearing minute hair, stout plumose seta and 2 long slender setae; stout plumose seta on ventral plate. *Abdomen.* Siphon with index about 2, conical; sub-ventral tuft a single rather stout plumose seta at 0·2; this seta may have 1 or 2 branches near its tip. Anal segment completely chitinised, posterior margin of saddle with spines as in *M. brevipalpis*; upper and lower caudal setae with about 8 and 5 simple branches respectively; lateral seta placed almost on posterior margin, very stout and coarsely plumose. Ventral brush and gills as in *M. brevipalpis*.

Distribution.—Heiban (*Bereir*); Wad Medani (*R. G. Sheehan*).

Uranotaenia alba Theobald.

Distribution.—Ajwong.

Uranotaenia balfouri Theobald.

Distribution.—Mgmunde's, Aga Falls, Thar Jath, Ajwong, Sheikh Toj, Malakal, Tonga, Keilak, Rahad, Abu Hagar and Hawata.

Uranotaenia candidipes Edwards.

Distribution.—Heiban (v.40, *Bereir*).

Aëdomyia africana Nev.-Lam.

Distribution.—Lake No, Malakal, Kodok, Ez Zuleit, Kosti and Shabak.

Theobaldia longiareolata Macquart.

With reference to the variation in abdominal markings described by Edwards (1941), most Sudan specimens are of the pale form. In one from Sinkat (among many pale specimens), one from Port Sudan and several collected in aircraft from Asmara several segments are largely dark and have a central median pale stripe.

Distribution.—Rufaa (*T. Dinning*); Kurma and Agaliya (*N. M. Ghanim*); Merowe (*A. Hassan*); Wadi Halfa (*M. M. Ismail*); Suakin, Gebeit and in tank

at Musmar (*El Huda*); Khor Arbaat (*Edwards*); Jebel Marra (*Abbott*); Sinkat (*M. Abdel Rahman*); Port Sudan and Faras.

Ficalbia splendens Theobald.

Distribution.—Juba, Malakal, Kodok, Khor Agwal, Ez Zuleit, Kosti, Shawal, Kereida, Kawa, El Amira, El Liri, Umm Dorein, Rahad, Sennar, Hag Abdalla and Danagla.

Ficalbia lacustris Edwards.

In some larvae from Keilak the comb-scales of the distal patch are arranged almost in a row.

Distribution.—Juba, 182 kilometres up Bahr El Jebel, Malakal, Tiptiap, Panamtin, Sheikh Toj, Keilak and Kosti.

Ficalbia mimomyiaformis Newstead.

Distribution.—Mabu, Malakal, Panamtin, Keri Kera, Jebelein, Kosti, Abu Hagar, Suelik, Seregaya, Danagla and Hawata.

Ficalbia mediolineata Theobald.

Distribution.—Adok, Kosti, Talodi and Abu Hagar.

Ficalbia uniformis Theobald.

Distribution.—Buffalo Cape, Tonga, Abu Tong, 182 kms. up Bahr El Jebel, 46 kms. up R. Zeraf, Ajwong, Malakal, Kodok, Keri Kera, Jebelein, Ez Zuleit, Kosti, Talodi and Damazin Cataract.

Ficalbia circumtestacea Theobald.

Distribution.—Abu Tong.

Taeniorhynchus metallicus Theobald.

Distribution.—Lado, Wani, Bor and Khor Barboi (*King*); Kaka (*H. Greene*); Renk (*Salaam*); Malakal (*L. H. Henderson*); Yubo, Buffalo Cape, Tonga and Juba.

Taeniorhynchus cristatus Theobald.

Distribution.—Lado and Malek (*H. Greene*); Yubo, Li Rangu, Yambio and Lake Jur.

Taeniorhynchus chrysosoma Edwards.

Distribution (checked by examination of male terminalia).—Sennar and Danagla.

Taeniorhynchus africanus Theobald.

Distribution.—There are scores of records of this species from places on the Nile between Juba and Jebelein and on the R. Zeraf and it probably occurs in large numbers all along these riverain areas. Other localities are: Akobo (*Henderson*), Amadi, Lau and Ekano (*F. W. Andrews*); Meridi and Li Rangu (*Woodman*); Opari (*El Huda*); Abu Kidada (*Ruttledge*); Boin (*R. H. A. Merlen*); Nimule, Yubo, Maignbara, Ler, El Amira, El Liri, Keilak, Talodi, Rahad, Sennar and Hawata.

Taeniorhynchus uniformis Theobald.

Distribution.—Like *T. africanus* this species is common on the Upper Nile and the R. Zeraf and in many inland parts of the southern Sudan. The two species usually occur together and *T. uniformis* is generally more numerous in catches. It extends a little farther to the north than *T. africanus*. *T. uniformis* has been found at all the localities mentioned for *T. africanus* except El Liri, Ekano and Boin and has also been found at the following: Nasser (*Henderson*); Er Ruat (*Ruttledge*); Torit, Yei, Yambio, Mbiris, Dingba, Kosti, Talha, Darisa, Umm Berembeita, Shabak, Abu Hagar, Tertera, Wad Medani, Wad El Magdub and Khartoum.

Aëdes scatophagoides Theobald.

Distribution.—Widely distributed in the southern and central Sudan. Some northerly records are from: El Fasher (*Abbott*); Kadugli, Umm Berembeita, Heiban, Wad Medani, Abu Usher, Khartoum and Nofalab; Zeidab (*R. G. Conolly*).

Aëdes caspius Pallas.

Distribution.—Gendettu (*W. E. Gifford*); Merga Oasis (*Prendergast*); Khartoum (uncommon), Kadaro, Faras and Suakin.

Aëdes aegypti L.

In this species the number of brown or creamy scales on certain parts of the body varies considerably. In the south such scales are usually absent. On the coast all females have many of these scales and may be regarded as *A. a.* var. *queenslandensis*. In northern inland areas (Bara, Wad Ashana, Sennar Gedaref, Kassala, Wadi Halfa etc.) some intermediate specimens are seen. Somewhat pale forms have also appeared in a laboratory stock obtained at Abdel Aziz.

Distribution.—Widely distributed in the southern and central Sudan and extending west of the White Nile about as far north as the 14th parallel. To the east, it has been found as far north as Erkowit. It has only once been found in the Nile valley north of Khartoum, and on the coast it is entirely replaced by the variety.

Aëdes aegypti var. *queenslandensis* Theobald.

In a collection from any coastal area this variety can always be identified with the naked eye. Every female has a more or less pale thorax and the contrast between the black scales of the legs and the brownish scales of the thorax is striking. The males are much darker than the females and often cannot be distinguished from inland specimens of the type form from northern areas. In the females of the variety the black scales of the type form are partly or wholly replaced by brown or creamy scales on the following areas. Head: two main dark patches on vertex. Thorax: all of mesonotum except white markings, dark area (when present) at apex of central lobe of scutellum, narrow scales of *ppn.* Abdomen: dark areas of tergites 1 to 6 (especially 1), usually greater part of sternites. Legs: basal part of anterior surface of first and second femora. The thoracic integument is often pale.

Distribution.—This variety is found on the coast and at a few places on the railway inland. Although often abundant in houses in the past, larvae have never been found in natural breeding places in the Sudan. A normal dark

female of the type form has been found at Erkowit, not far inland, and an analogous finding at Ailet in Eritrea is recorded by Lewis (1943b). The coastal area in which var. *queenslandensis* occurs in the absence of the type form is thus very restricted. The variety probably occurs at many places round the Red Sea; specimens have been received from Mecca (*B. Es Sayed*) and Kamaran Island (*Major D. Thompson*). Localities in the Sudan are: Aqiq, Dongonab, Halaib and Mohamed Gul (*Edwards*); Port Sudan, Suakin, Tokar, Gebeit, Sinkat and Kassala.

Aëdes simpsoni var. *lilii* Theobald.

Distribution.—Meridi, Malakal, Heiban, Kauda, Roseires and Sennar; in an aeroplane (Whitfield, 1939) at Khartoum.

Aëdes metallicus Edwards.

Distribution.—Widely distributed in the southern and central Sudan. Localities are as follows: Wad Ganatir and Dagu (*Ghanim*); Malakal (*O. H. Medani*); Kudring (*A. A. Mohamed*); Kalora (*Ruttledge*); Kadugli (*F. L. Wheaton*); Wad Banda, Kheiwok, Mug, Sheikh Gamal and Shaloat (*M. H. S. Ahmed*); Khartoum (*Glass*); Kassala (*A. M. El Hag*); Raga, Heiban, Sheikh Karim, El Fasher, Nahud, Roseires, Sennar, Wad Medani and Abu Usher.

Aëdes africanus Theobald.

Distribution.—Sopo (*H. D. Fairman*); Li Rangu (*J. F. E. Bloss*).

Aëdes luteocephalus Newstead.

Distribution.—In aeroplane at Khartoum (Whitfield, 1939); Sennar, Danagla, Wad El Magdub, Malakal and Heiban.

Aëdes unilineatus Theobald.

Unlike the specimen figured by Hopkins (1936), larvae from the Nuba Mountains have comb spines which appear simple under a low magnification. The basal denticles are very small and inconspicuous.

Distribution.—Tembura (*El Huda*); Jebel Moya (*O. Shubeika*); Heiban, El Fasher, Sennar, Wad Medani and Wad El Magdub.

Aëdes vittatus Bigot.

Distribution.—This species is widely distributed in Equatoria and the Nuba Mountains. Near its northern limit it is usually found only on rocky hills. Some northern records are from: Geneina (*E. K. Maurice*); Kassala (*El Hag*); Jebel Mandera (*M. Bell*); Jebel Meidob (*A. P. G. Michelmore*); Jebel Gurein and Gedaref (*Ghanim*); Doka (*El Huda*); Khartoum (*Ruttledge*, xi.43); Umm Ruaba (*A. Mohamedin*); Malakal, Kosti, El Obeid, Roseires, Damazin Cataract and Sennar (breeding place in concrete of Dam). The records from Kosti and Khartoum were probably due to chance introductions.

Aëdes stokesi Evans.

Distribution.—Juba (*A. M. Birrell*).

Aëdes argenteopunctatus Theobald.

Distribution.—Malakal and Akobo (*Henderson*); Nasser (*King*); El Hamra (*Salaam*); Kalora (*A. A. Mohamed*); Amadi (*Andrews*); Wau (*Wheaton*); Heiban, Sennar and Wad Medani.

Aëdes leesoni subsp. *verna* Lewis.

The adults and early stages were described by Lewis (1944a).

Distribution.—Kerripi (*El Huda*); Heiban (*Bereir*); Kadugli (*H. Ali*); Wad Medani and Danagla.

Aëdes dalzieli Theobald.

Distribution (terminalia of males examined).—Juba, Sennar and Wad Medani.

Aëdes cumminsi Theobald.

Distribution.—Meridi, Umm Berembeita (*M. S. En Nur*).

Aëdes arabiensis Patton.

The following accounts have each been made from the examination of seven pelts from Wad Medani (vi.41, viii.42).

Pupa. Does not differ appreciably from that of *A. hirsutus* as described by Edwards (1941).

Larva. *Head.* Antenna about 0·5 length of head, shaft with small spicules, tuft of 7–11 branches inserted at about 0·3. Median hairs of mouth brush with comb at tip. Setae A, B and C plumose, A with 7–8 branches, B single, C single or double, almost directly behind B, *d* very small with about 5 branches. Mentum roughly triangular with about 15 teeth on each side of the centre. *Abdomen.* Comb a patch or irregular row of 8–12 sharp-pointed spines with small basal denticles. Siphon with index about 2·5, pale, tuft with 7 or 8 branches at about 0·7; pecten reaching slightly beyond middle, of about 20 teeth varying in shape, a few at base often simple; central teeth with 1–4 basal denticles of varying size; of the last 1–3 teeth usually 2 larger and widely spaced, one or all simple or with 1–3 basal denticles. Anal segment nearly ringed by saddle; upper caudal seta with 4–7 branches, lower single; lateral seta single or (occasionally) double; ventral brush of 5 pairs of multiple tufts in barred area and 3 or 4 unpaired tufts proximal to it. Gills subequal, lanceolate, much longer than saddle.

Distribution.—*A. arabiensis* and *A. fowleri* are the common species of *Aëdimorphus* in the north-eastern Sudan. Localities are: Dueim (*A. Taher*); Abu Usher and Abu Ideina (*M. Mulasim*); Ezeirgab, Omdurman, Eilafun and Wadi Sidna (*Glass*); Hassa Heissa (*Dinning*); Kassala (*Ghanim*); Wad Medani and Kosti; Argo (*H. Saleh*).

Aëdes centropunctatus Theobald.

Distribution.—Meridi; Li Rangu (*Ruttledge*); Acholi (*King*).

Aëdes hirsutus Theobald.

Distribution.—El Fasher (*Abbott*); Kadugli (*A. R. Atabani*); Dilling (*O. Rahmi*); Dunger, Heiban and Rashad.

Aëdes fowleri d'Emm. de Ch.

Distribution.—Amadi (*Andrews*); Juba (*Birrell*); Dilling (*Rahmi*); Barakat (*Sheehan*); Jebel Moya, Roseires, Dueim, Khartoum, Hawata and Gedaref.

Aëdes ochraceus Theobald.

Distribution.—Akobo and Abwong (*Henderson*); Talodi (*Cowland*); Mahbuba (*Ruttledge*); in aeroplane at Khartoum (Whitfield, 1939); Heiban and Kosti.

Aëdes lineatopennis Ludlow.

Distribution.—El Hamra (*Salaam*); Wad Medani.

Aëdes circumluteolus Theobald.

Distribution.—Wau (*Wheaton*); Khor Barboi and K. Nyawa (*King*); El Hamra (*Salaam*); Roseires (*Khidr Ahmed*); Yubo, Juba, Malakal, Kosti, Abu Geili, Sennar, Wad Medani and Khartoum.

Aëdes albicosta Edwards.

Distribution.—Juba.

Aëdes palpalis Edwards.

Distribution.—Juba.

Aëdes furcifer Edwards.

The amount of pale speckling on the abdomen is so variable in Sudan specimens that often it cannot be used for separating *A. furcifer* from *A. taylori*. Old records therefore require confirmation by examination of the male terminalia.

Distribution (male terminalia examined).—Heiban.

Aëdes taylori Edwards.

A larval pelt from Wad El Magdub was examined in which the siphonal index is little more than 3 and head-setae C have 4 and 5 branches. This suggests that all or many Sudan larvae of *A. taylori* and *A. furcifer* are indistinguishable from each other.

Distribution (male terminalia examined).—Juba, Heiban and Wad El Magdub.

Eretmopodites chrysogaster Graham.

Distribution.—Li Rangu (*C. B. Symes*); Juba (*Ghanim*); Meridi.

Eretmopodites quinquevittatus Theobald.

Distribution.—Wau (*Burrows*); Li Rangu (*Woodman*); Juba (*R. Charlton*).

Culex tigripes Grp. and C.

Distribution.—Widely distributed in the southern and central Sudan. Edwards's (1941) statement that the variation in abdominal markings " does seem to correspond to some extent with geographical distribution, although not in any precise manner " appears to apply as well to the Sudan as to the Ethiopian Region generally. Form IV tends to be common in the north and form II in the south, although there are many exceptions and the two are often found in the same place.

Form I : Talodi (*Ruttledge*).

Form II : Meridi, Talodi and Delami (*Ruttledge*); Li Rangu (*Hunt*); Juba, Torit, Yubo, Okaru, Malakal, Abbasiya, Umm Dona, Geneina, El Fasher, Gallabat, Aba Island, Damazin Cataract, Hawata, Gereif, Khartoum (fewer than form IV) and Bahr El Jebel; in an aeroplane from Asmara at Khartoum (*Williams*).

Form IV : R. Sobat and Khor Barboi (*King*); Juba, Aba Island, Wad Hashim, Sennar, Barakat and Wad Medani; Gereif and Khartoum (*Glass*). Specimens with paired yellowish spots on abdominal tergites 2 to 4 but with few yellowish scales on tergites 6 to 8 have been found at Wau (*Burrows*), Kau (*E. D. Pridie*) and Juba.

Culex arbieeni Salem.

The single available larva, apparently of this species or a variation of it, is without antennae but is otherwise undamaged and corresponds closely with Salem's (1938) description of the type specimen from southern Sinai. The only differences are that the three distal sub-ventral setae of the siphon are single, the lateral setae of the siphon are not arranged in a straight line, there are five pairs of tufts in the ventral brush, and the upper and the lower caudal setae are double and single respectively.

The following additional points were noted. Head-seta *d* is single. The dorsal surface of the thorax is densely clothed with spicules and there are many spicules on the dorsal surfaces of the first eight abdominal segments and on the postero-lateral surface of the ninth. The comb is composed of about 50 scales and the distal are much larger than some of the proximal ones. The lateral seta of the ninth segment is small and has three branches.

Distribution.—Jebel Marra (rock pool beside stream, over 6000 ft., 7.ii.44, *Abbott*).

Culex nebulosus Theobald.

Distribution.—Widely distributed in the southern Sudan and the Nuba Mountains. Some northern records are : El Fasher (*I. W. Hyan*); Tendelti, Es Saata, Abu Zabad, Gedaref, Qala en Nahl and Nahud (*Ghanim*); Khartoum (*King* in 1931, now rare or absent); Sennar, Rahad and Jebel Auliya.

Culex cinereus Theobald.

Distribution.—Wau (*Fairman*); Latuka, Torit and Rejaf (*Ghanim*); Umm Berembeita (*A. R. Dafalla*); Kala and Heiban.

Culex macfiei Edwards.

Distribution.—Heiban (*Bereir*).

Culex simpliciforceps Edwards.

The following accounts are based on the examination of one pupa and five larvae collected at Kosti on 6.i.43.

The pupa was identified by dissecting out the (male) terminalia. The larvae are almost certainly of the same species.

Pupa. The specimen is damaged but the following points can be made out. Trumpets and paddle as in *C. inconspicuosus* (Edwards, 1941). Seta P double, K with two branches from much beyond base. C–II with many fine branches, III about 7-branched, IV 8 to

10-branched, V 6 or 7-branched, VI 3-branched; B–III double, IV 4 or 5-branched, V double, longer than succeeding segment; A–VII with 3 main branches each further divided into 2.

Larva. Differs from that of *C. inconspicuosus* (Hopkins, 1936) as follows. Comb a patch of 30–35 teeth composed anteriorly of scales and posteriorly of larger spines. Ventral brush of 6 pairs of tufts in the barred area and 2 small single or double setae proximal to it.

Distribution.—Kosti.

Culex poicilipes Theobald.

Distribution.—Widely distributed in the southern Sudan and along the White and Blue Niles in the central Sudan, uncommon in the Nuba Mountains. The species breeds in vast numbers in the Jebel Auliya and Sennar Reservoirs. Some northerly localities are: Wad Medani, Merebea, Khartoum, Hawata and Wad Arud.

Culex bitaeniorhynchus Giles.

Adults from Kosti are very dark. The pale scales on the wings are never very numerous and are almost absent in some specimens. It is of interest that some specimens of this kind collected at Kosti in 1933, and examined by Edwards, are labelled " var. nov." It is probable that he did not later describe them as a new variety owing to the variability of the number of pale scales on the wing. Specimens from the other localities mentioned below are dark.

Distribution.—Juba, Kosti (printed as Koshi in Edwards, 1941), Zeinuba, Guli and Danagla.

Culex ethiopicus Edwards.

Edwards (1920) found that the larva of this species seemed to be indistinguishable from that of *C. bitaeniorhynchus* of which *C. ethiopicus* was then considered to be a variety. Thirteen damaged pelts from Wad Medani (vii.42) and Hawata (viii.42) have been examined, and the number of branches of head-seta *f* and of the sub-ventral tufts of the siphon found to be variable. In 14 examples of seta *e* all were double except two which had three branches. In 20 examples of *f* the number of branches varied from 2 to 5 and averaged 3·3. The siphonal tufts were usually double or triple but in some cases single or 4-branched. In the latter two of the branches were minute.

The position regarding the identification of the larvae of the *bitaeniorhynchus* group in the Sudan appears to be as follows. Larvae of *C. bitaeniorhynchus* and *C. ethiopicus* are indistinguishable. They can probably be differentiated from *C. annulioris* and *C. a.* var. *consimilis* by examining head-seta *e*. In some larvae from Kosti *e* has five branches and it remains to be seen whether they represent an intermediate form.

Distribution.—*C. ethiopicus* appears to be the common representative of the *bitaeniorhynchus* group in the central Sudan except on the White Nile where *C. bitaeniorhynchus* itself is common. Localities are: El Fasher (*Hyan*); Talodi (*Ruttledge*); Wad El Magdub (*W. P. L. Cameron*); Kauda (*F. G. S. Whitfield*); Wau, Li Rangu, Heiban, Obol, Kosti, Sennar, Danagla and Wad Medani.

Culex annulioris Theobald.

As Edwards (1941) pointed out, forms intermediate between the type form and var. *consimilis* occur.

A male and female from Li Rangu have apical lateral pale triangles on

abdominal segments 2 to 7 but no median basal triangles or seven spots. The terminalia of the male are also of an intermediate character.

Distribution.—Li Rangu (*Hunt*).

Culex sitiens Wiedemann.

Larval pelts of this species from Port Sudan show a marked difference in length of the siphon from the Indian (Barraud, 1934) and East African (Hopkins, 1936) form in which the index is from 2 to 2·5. In the eight Port Sudan specimens the index varied from 4·5 to 5·9 and averaged 5·1. Similar larvae have been obtained from Kamaram Island (*Thompson*) and Massawa (Lewis, 1943), and it seems probable that the long siphon may represent a variation or variety of the Red Sea area. In view of the variability of the index in the Port Sudan specimens and in many species of *Culex* it is desirable that specimens should be obtained from other places before the status of the Port Sudan form is decided. The adults of both sexes of the Port Sudan specimens were of the Red Sea form described by Edwards (1941) and it will be interesting to know if this adult form is generally associated with a high larval siphon index.

In the eight Port Sudan pelts head-setae B and C had 4–7 and 6–9 branches respectively.

Distribution.—Suakin and Tokar.

Culex sp. indet.

Some larvae collected in swamps somewhat resemble those of *C. tritaeniorhynchus* but differ in having double subventral tufts on the siphon and only two branches on the upper caudal seta.

Distribution.—Malakal and Panamtin.

Culex duttoni Theobald.

Distribution.—Common in the southern Sudan and Nuba Mountains but apparently absent from the large agricultural areas north of Kosti and Sennar where many other species occur. Some northern records are : Geneina (*B. El Tigani*); Delami (*A. A. Mohamed*); Zalingei (*Abbott*); El Obeid and Kassala; Kebkabiya and Deleig (*Ghanim*).

Culex theileri Theobald.

Edwards found that, as with many species, specimens of *C. theileri* from desert regions tend to be much paler than the normal. Specimens recently obtained at Faras have pale brown mesonotal scales and most show the pale variation of the abdominal tergites described by Edwards. They thus resemble the pale specimens found by Salem (1940) in Sinai and differ markedly from dark specimens collected by the author on the Eritrean Plateau. In one specimen from Faras the first five abdominal tergites have barely a trace of a pair of pale spots.

Distribution.—Wadi Halfa and Faras (Lewis, 1944); in aeroplane from Eritrea at Khartoum (*Williams*).

Culex univittatus Theobald.

This species shows considerable variation in the number of post-spiracular scales and the degree of banding of the abdominal tergites, and the two variations

are often correlated. Apart from females without abdominal dorsal pale bands, of which all those that have been seen are var. *neavei*, specimens of this sex can be readily placed in one of two groups. Those of the first have complete pale bands and more than ten, usually about 20, post-spiracular scales. All specimens from places north of Khartoum fall into this group. In the second group some or all of the bands are incomplete and not continuous with the basal lateral white spots. Many specimens have ten or fewer post-spiracular scales. The males of *C. univittatus* usually have more developed abdominal dorsal banding and fewer post-spiracular scales than the females.

Distribution.—This is the commonest Culicine in many parts of the country and probably occurs all along the 3548 kilometres of river from Nimule to Faras. It is uncommon in the dry season at Erkowit where *C. sinaiticus* is the common species. Some northern records of *C. univittatus* away from the Niles are : El Fasher (*Hyan*); in an aeroplane at Port Sudan (*Edwards*); Rahad, Tendelti, Aroma, Hawata and Gedaref; Derudeb and Aqiq (*Ghanim*); Niertete and Jebel Marra (*Abbott*); Nawa, El Ein and Jebel Gurein (*Ghanim*).

Culex univittatus var. *neavei* Theobald.

Specimens corresponding exactly with Edwards's (1941) description are sometimes seen. Many Sudan females of *C. univittatus*, however, have no abdominal dorsal pale bands and have from one to ten normal, or one to 15 narrow, post-spiracular scales. There is a tendency to reduction of the pale line on the anterior surface of the hind tibia. The associated males have fewer post-spiracular scales and sometimes none, but may show some abdominal pale banding. These males and females may be comparable with the variation described under the heading of var. *neavei* by Edwards (1941), and it is proposed to regard them for the present as belonging to this variety. They are often found along the swamps of the White Nile and, unlike typical *C. univittatus*, appear to bite man not infrequently.

Edwards (1941) considered that the true status of *neavei* was uncertain and that it might just possibly be a hybrid between *C. univittatus* and *C. antennatus*. It may be noted that in the places in the Sudan where *neavei* (as defined above) has been found *C. antennatus* was usually found but sometimes much less commonly than *C. univittatus*. The tendency of *neavei* to bite man is interesting, since *C. antennatus* is a troublesome biter.

Distribution.—Juba, Malakal, Kosti, Heiban, Wad Medani and Sennar. It is probably widely distributed along the Upper Nile.

Culex simpsoni Theobald.

Distribution.—Mvolo, Damazin Cataract and Wad Arud; Gallabat (*M. M. Hassan*). It has not been found in Khartoum in the last few years despite extensive collecting, and some old males labelled " Khartoum " were found, on examination of the terminalia, to be dark specimens of *C. univittatus*. It appears therefore that Edward's Khartoum record requires confirmation by further findings. His record of Agur Mar is probably a misprint for " Agur, March." *C. simpsoni* has not been found at Wad Medani in recent years.

Culex sinaiticus Kirkpatrick.

Head-seta B is usually double, occasionally single or triple. It was double at least on one side in all of 24 specimens examined from Erkowit, El Fasher,

Port Sudan, Aqiq, the Nuba Mountains and Rahad. One specimen from Rahad had a triple seta on one side. In three specimens examined from the Damazin Cataract seta B was single and the subventral tufts of the siphon had about five branches. Forty-one well-preserved specimens from Jebel Marra were examined; in 27 the seta of both sides was double, in seven that on one side double and on the other single, and in four that of both sides was single. The character is not always easily determined because the two branches often lie parallel and touching each other.

In the comb a number of scales are always present in the anterior part.

Distribution.—Guldo (in permanent stream from Jebel Marra), J. Marra (7000 ft. at Koronga and elsewhere), Niertete and El Fasher (*Abbott*); Aqiq (*Ghanim*); Erkowit (*Ruttledge*); Roseires, Heiban, Koma, Kologi and Rahad.

Culex laticinctus Edwards.

Distribution.—Khor Arbaat (*Edwards*); El Fasher (*Abbott*); Sinkat (*Abdel Rahman*); Jebel Moya.

Culex pipiens L.

The three available specimens from Malakal and Jebel Marra appear to belong to the type form of this species. A male from the former and a female from the latter have distinct median and postero-lateral dark patches on the abdominal sternites, thus differing from *C. p.* subsp. *molestus* (Jobling, 1938). In the female from Jebel Marra the pale bands of the abdominal tergites are reduced as in African specimens described by Edwards (1941). In the male from Jebel Marra the first four segments of the palps only just exceed the proboscis in length but the abdominal ventral median markings are distinct (the postero-lateral areas are hidden). The numbers of setae on the ninth tergite (sum of both sides) of two males from Malakal were 14 and 13 and of one from Jebel Marra 11.

In two larvae from Jebel Marra the siphonal indices are 5·8 and 6·1.

Distribution.—Malakal (*O. Medani*); Jebel Marra: adults on vegetation covered with hoar frost, about 10,000 feet (11.ii.38, *A. W. M. Disney*); 7000 ft. Koronga, larvae in pool at edge of stream and at 6000 ft. (9.ii.44, *Abbott*).

Culex pipiens subsp. *molestus* Forskål.

The identity of the mosquito resembling *C. pipiens* which occurs between Khartoum and the Egyptian frontier is not easily determined. For the present it may be regarded as *C. p. molestus* although it differs somewhat from the European form. It must be remembered that *C. pipiens* L. may be present in some part of the area and that hybrids may occur. The mosquito in question must be compared with both the European and the African form of *C. pipiens* which, as Edwards showed, tend to differ in markings. Jobling (1938) has assembled, and added to, our knowledge of *C. pipiens* and *C. p. molestus* in an extensive account of the biological and structural characters of the larvae and adults of each.

The form under discussion has been found breeding in wells, in the bilge-water of barges, in pit latrines and in pools. Females have been seen biting man indoors by day and night. Their presence has sometimes caused complaints (at Khartoum and Wadi Halfa) and they were doubtless very troublesome in the days before anti-mosquito measures were started.

The adult, in general colouring, is dark brown and is not appreciably paler than Sudan and Abyssinian specimens of *C. pipiens*. There is no tendency towards reduction of the pale bands of the abdominal tergites. The abdominal sternites are usually pale but faint median dark patches are sometimes seen. The pale spot at the tip of the hind femur is faint. The first four segments of the palps of the males are together about equal in length to the labium, sometimes slightly shorter or longer. The third segment is somewhat curved. The number of setae on a lobe of the ninth tergite is very variable. In 30 males, from Khartoum, Wadi Halfa and Faras, the number varied from 5 to 16 and the average was 8·9. Taking the sum of both sides to eliminate minor differences, the minimum was 11, the maximum 30, the mean 17·8, and the standard deviation 3·74. There were no values between 22 and 30. In only four specimens was the number of setae the same on each side, and in one specimen there were seven on one side and twelve on the other. Jobling (*loc. cit.*) found that the number of setae could be used to indicate the presence or absence of *C. p. molestus* among specimens but in the Sudan the character is evidently too variable for this purpose.

Larval characters were observed in pelts of larvae which were collected at different places and bred at Wad Medani, the adults of each being preserved for identification. The range and mean values of the siphonal index are shown in table I. Plotting the frequencies of the indices for the batches of larvae

TABLE I.

The siphonal indices of larvae of *Culex pipiens* (regarded as subsp. *molestus*) from different breeding-places. Measurements were made from pelts which were identified by examination of the adults which emerged.

Locality	Breeding-place	Month (1943)	No. of pelts	Siphonal index			
				Min.	Max.	Mean	S.D.
Khartoum	Barge (from one egg batch)	June	36	3·6	4·7	4·2	0·3
,,	,, ,, ,, ,,	,,	18	3·6	4·3	4·0	0·3
,,	,, (collected as larvae)	,,	13	3·6	4·4	4·0	0·2
Omdurman	Pit latrine	,,	3	3·5	4·0	3·7	0·2
Wadi Halfa	Irrigation well and pool	April	29	3·8	4·9	4·5	0·3
Faras	Saline pools	,,	29	4·2	5·3	4·8	0·3
,,	,, ,,	Dec.	10	3·9	4·8	4·3	0·3

Frequency distribution of indices of all 138 larvae pooled

Index	3·5	3·6	3·7	3·8	3·9	4·0	4·1	4·2	4·3	4·4
No.	1	6	4	4	8	10	12	14	14	18
Index	4·5	4·6	4·7	4·8	4·9	5·0	5·1	5·2	5·3	
No.	10	6	8	11	4	2	2	3	1	

Maximum	5·3
Minimum	3·5
Mean	4·3
Standard deviation	0·4
Coefficient of variation	9

numbering more than 15 gave a bi-modal curve in each case but the numbers were too small for statistical analysis. Both modes were high in curves with a high mean. The difference was not due to sex, but a slightly lower mean index

for males appeared to cause the peak for lower indices to be bigger than that for higher indices. The figures for the sexes are as follows.

	Number	Mean	Min.	Max.	Stand. dev.
Males . . .	50	4·2	3·5	5·2	0·4
Females . . .	71	4·4	3·6	5·3	0·4

Some larvae show a slight sigmoid curvature. The ventral valves and the lever of the valves vary in shape but some specimens are of the *C. pipiens* form.

The mosquito in question resembles *C. p. molestus* in its biting habits and to some extent in its breeding-places. Adult characters corresponding to those of European *C. p. molestus* are colouring of the abdominal sternites and the tip of the hind femur and the form of the male palps. In its general dark colouring it resembles European *C. pipiens* more than *C. p. molestus* but differs from both in the great variability of some of its characters. It differs from the *C. pipiens* of central Africa in showing no tendency to lose its abdominal pale bands. In its siphonal index it resembles *C. p. molestus* rather than *C. pipiens* but has a higher maximum than the former does in Europe.

Distribution.—Khartoum and neighbourhood (*Glass*); Shendi and Damer (*A. H. Hussin*); Wadi Halfa and Faras. This mosquito has only been identified definitely from places along the main Nile. Larvae of this subspecies or *C. pipiens* have been collected at Hassa Heissa (*O. Shubeika*).

Culex fatigans Wied.

The identification of individual females and larvae of *C. fatigans* is not always easy in a country where the very similar forms *C. pipiens* and *C. p. molestus* occur. It is, however, often desirable to do so because specimens of this potential vector of yellow fever are not infrequently found in aircraft, or biting in houses or breeding in towns.

The numerical character for the female given by Edwards (1941) is the length of the anterior wing fork divided by its stem. The most easily measurable characters of the larva given by Hopkins (1936) are the form of head-seta *f* (single or double) and the siphonal index. In table II are summarised the measurements of these characters in specimens from Suakin and

TABLE II.

Characters of *Culex fatigans* from Suakin. Larval pelts (identified by examination of emerging adults); number of branches of head-seta *f* and siphonal index. Females; relative length of upper fork cell of wing.

	Sum of branches of head-setae *f* of both sides		Siphonal index		Length of upper fork cell divided by length of stem
	Males	Females	Males	Females	Females
No. of specimens .	26	21	29	19	25
Maximum . .	10	10	4·7	4·6	3·5
Minimum . . .	6	5	3·8	3·7	2·1
Mean . . .	7	7	4·2	4·1	2·7
Standard deviation .	1	1	0·2	0·3	0·2

Port Sudan. The identity of the females was established by examining males bred from the same egg batches which came from Port Sudan. Larval pelts (of males) were from specimens collected in two wells at Suakin (18.i.44) and bred to maturity at Wad Medani. They were identified by examining the terminalia of the emerging males. Figures are given for larvae of females from the same breeding-places to show that there is no important difference between the sexes.

The length of the upper fork of the wing was taken as that of its lower branch. The average relative length is sometimes as much as that given by Edwards for *C. pipiens*.

As in some Eritrean specimens (Lewis, 1943) most Sudan larvae have more branches on head-seta *f* than the number given by Hopkins. Of 52 setae examined on 26 larvae none was single and only one was double. The maximum number of branches was six. Hopkins gives the average number of branches in *C. pipiens* as about six. The examination of 11 pelts of *C. p. molestus* from Faras showed an average of 10 and a range of from 7 to 13 for the sum of the branches of both sides of the head. In the Sudan therefore the character of head-seta *f* is often of no value for individual larvae and an additional disadvantage is that it is often difficult to see owing to its position above the imaginal eye.

The siphonal index is of no value in many specimens because its range is within that of Sudan *C. p. molestus* and overlaps that of *C. pipiens* as given by Jobling (*loc. cit.*).

Some other characters of the larva are variable. Head-seta *f* is usually more than half as long as *e* in *C. fatigans* and less than half in *C. p. molestus*, but the length of these delicate and tapering, and often curved, setae is often difficult to measure. The siphon is often appreciably wider at about a third of its length from the base but not invariably so. With regard to the number of pecten spines, larvae of *C. fatigans* have been seen with as many as 13 on one side. Furthermore the number cannot easily be counted because spines readily become dislodged without leaving a scar and some of the basal spines may be minute.

The above observations show that great care is required in identifying any Sudan specimens of *C. fatigans* other than males.

Distribution.—Suakin and Port Sudan (*Hoare*); Erkowit (*King*); Sinkat (*M. Abdel Rahman*); Kassala and Khatmia; Aqiq (*El Huda*).

This species appears to be restricted to the coastal area, part of the Red Sea Hills and the neighbourhood of Kassala. Other records are thought to be erroneous. Balfour (1904) referred, in 1904 and in various writing up to 1913, to the common biting *Culex* of Khartoum as *C. fatigans* and also recorded it from various places on the Upper Nile. The author has examined the terminalia of several old specimens of males labelled *C. fatigans* from Wadi Halfa and elsewhere and found them to be of the *C. pipiens* form, and has examined many specimens from Khartoum in recent years without seeing any *C. fatigans*. It should also be noted that Edwards's (1913) figures of the terminalia of the two species appeared after the old records were made. The Upper Nile records probably refer to *C. antennatus*.

Culex antennatus Becker.

Many bred specimens are somewhat dark, perhaps because they were killed soon after emergence.

Distribution.—Kosti, Dueim, Keilak, Rahad, Heiban, Sennar, Jebelein, Umm Berembeita and Danagla. This species is abundant at many places on the White Nile south of Jebelein.

Culex decens Theobald.

Distribution.—Widely distributed in the southern Sudan. Some northern records are: Delami (*Ruttledge*); Kosti, Rahad, Keilak, Bara, Roseires, Hawata, Khartoum, Tendelti and Doka; Wad Banda (*Ghanim*); Abbasiya (*M. S. En Nur*), El Fasher (*Abbott*).

Culex perfuscus Edwards.

De Meillon and Rebêlo (1941) noted that a male with terminalia resembling those of *C. perfuscus* had developed from a larva the somewhat denuded pelt of which resembled that of *C. perfidiosus* as described by Hopkins (1938). The author has obtained, from Danagla, a series of 17 adults of *C. perfuscus*, the associated larval pelts of which also agree with the description of *C. perfidiosus*. I have corresponded with Mr. Hopkins about this species and there seems no doubt that the description is of the larva of *C. perfuscus*. The record of *C. perfidiosus* from the Nuba Mountains (Lewis, 1943a) was made from a larva which proves to be *C. perfuscus*.

Distribution.—El Fasher (*Hyan*); Danagla, Wad Medani, Rahad, Abu Zabad, Sennar and Heiban.

Culex weschei Edwards.

Distribution.—Talodi (*A. K. Abdalla*); Gambo (*Ghanim*).

Culex ingrami Edwards.

The larva is of the Gold Coast form described by Hopkins (1936). Of the two available larvae, one has two and the other three mid-ventral spines on the siphon.

Distribution.—Yubo.

Culex guiarti Blanchard.

Distribution.—Mabu and R. Mayuku.

Keys for Identification.

Some of the observations described above have necessitated alterations to the keys in *Mosquitoes of the Ethiopian Region*, primarily for use in the Sudan. They comprise substitutes for and notes on some sections in the existing keys, as shown below.

ADULTS.

Chaoborus.

Legs uniformly pale . . . . . *pallidipes.*
Legs pale with dark rings . . . . . *ceratopogones.*

Aëdes (*Stegomyia*).

3. Front half of scutum entirely clothed with white scales
mascarensis Macgr. (p. 153).
Front half of scutum with white or yellow markings on black or brownish ground . . . . . 3a.

3a. Ground colour of scutum brown
aegypti var. *queenslandensis* Theo. (p. 130).
Ground colour of scutum black . . . . . 4.

Aëdes (*Aëdimorphus*).

25. Scales on *apn* and *ppn* nearly all broad and flat . . *leesoni* Edw. (p. 183).
These scales narrow or mostly narrow . . . . . 25a.
25a. Scales on *ppn* narrow and intermediate . . . *leesoni* subsp. *verna* Lewis.
Scales on *ppn* narrow . . . . . 26.

Aëdes (*Diceromyia*).

4. With pencil of long hairs at tip of coxite . . . . *furcifer* Edw. (p. 214).
Without these hairs . . . . . *taylori* Edw. (p. 216).

Culex (*Neoculex*).

8. Mesepimeron with a large or medium-sized (in *arbieeni*) patch of scales . . . . . 9.
Mesepimeron with very few or no scales . . . . . 11.
10. *Note.*—After " (p. 256) " insert " and *arbieeni* Salem " and add footnote : " Only Sinai specimens examined ".

Culex (*Culex*).

3. Proboscis with a pale spot at tip above (before labella) . . . . . 4.
Proboscis dark at tip (though labella may be pale); wings with few or no pale scales . . . . . 5.
19. *Note.*—Some specimens provisionally allotted to *C. univittatus* var. *neavei* have some post-spiracular scales and no pale bands on the abdominal tergites.
34. Abdominal sternites entirely pale or with a few dark scales on centre line; palpi in ♂ about as long as proboscis . . . . . 34a.
Abdominal sternites with distinct median, and usually postero-lateral, dark patches; palpi in ♂ longer than proboscis . . . . *pipiens* L. (p. 314).
34a. Upper fork cell in ♀ over three times as long as its stem; abdominal tergites with creamy bands . . . . . *pipiens* subsp. *molestus* Forsk.
Upper fork cell in ♀ usually less than three (but sometimes 3·5) times as long as its stem; abdominal tergites with whitish bands *fatigans* W. (p. 316).

LARVAE.

Megarhinus.

Subventral tuft of siphon with 3–5 branches . . . *brevipalpis* (p. 32).
This tuft consisting of a single seta . . . . . *viridibasis*.

Aëdes.

10. Stellate setae on thorax not very large . . . . *dendrophilus* (p. 118).
These setae prominent . . . . . *unilineatus* (p. 123).
26. Antenna very sparsely spiculate; pecten composed of very closely set spines of which only the most distal is wider spaced . *vittatus* (p. 124).
Antenna more strongly spiculate; pecten spines less closely set and usually with two or more of the distal spines more widely set . . . 26a.
26a. Pecten spines with several basal denticles. . . . . *arabiensis*.
Pecten spines with only one basal denticle or none . . . . . 27.
29a. *Note.*—In the second alternative delete " 3 " and substitute " 2 ".
34. *Note.*—The only known Sudan tree-hole breeders indicated by this section or by sections following from it are *furcifer* and *taylori*.
41. Antennae longer than head . . . . . 42.
Antennae shorter than head . . . . . 41a.
41a. Antennae slightly shorter than head . . . . . *leesoni* subsp. *verna*.
Antennae much shorter than head . . . . . 43.

Culex.

2. *Note.*—At end of second alternative delete " 3 " and substitute " 2a ".
2a. Siphon with subdorsal setae on distal two thirds . . . . . *arbieeni.*
Siphon not so . . . . . 3.
12. Comb composed wholly or partly of spines . . . . . 12a.
Comb composed of scales . . . . . 23.
12a. Comb composed mainly of scales . . . . . *kingianus* (p. 184).
Comb composed wholly or mainly of spines . . . . . 13.
13. Comb composed of spines except for some scales in proximal part *sinaiticus* (p. 221).
Whole of comb composed of spines . . . . . 14.
19. Head-seta *e* with 2–3 moderately long branches *bitaeniorhynchus* (p. 198) and *ethiopicus.*
Head-seta *e* with about 6 much shorter branches; subventral tufts of siphon with 3–4 branches *annulioris* (p. 197), *a.* var. *consimilis* and *aurantapex* (p. 199).
20a. *Note.*—At end of the second alternative delete " 21 " and substitute " 22 ".
21. *Note.*—This section should be omitted.
23. *Note.*—At end of the first alternative delete " *inconspicuosus* 190) " and substitute " 23a ".
23a. Comb a patch of about 40 rather narrow scales *inconspicuosus* (p. 189) and probably *fimbriforceps* (p. 190).
Comb a patch of 30–35 scales and spines . . . . . *simpliciforceps.*
26. Siphonal index about 5 or less . . . . . 27.
Siphonal index about 6 or more . . . . . 26a.
26a. Siphon with slight sigmoidal curvature . . . . . *pipiens* (in part).
Siphon without such curvature . . . . . 37.
31. *Note.*—After " *sitiens* " add " in part ".
33. *Note.*—Delete " *thalassius* (p. 199) " and substitute " 33a ".
33a. Comb of about 35 scales . . . . . *sitiens* (in part, Red Sea area).
Comb of about 65 scales . . . . . *thalassius* (p. 199).
34. *Note.*—The species indicated is not *C. perfuscus.*
36. Head-seta *f* usually less than $\frac{1}{2}$ length of *e*, and with average of 3·5 branches; siphon usually with markedly convex sides . *fatigans* (p. 208).
Head-seta *f* usually more than $\frac{1}{2}$ length of *e*, and with about 6 branches; siphon usually with less convex sides *pipiens* in part (p. 207), subsp. *molestus* and *tamsi* (p. 216).
40. *Note.*—Delete " *tritaeniorhynchus* (p. 201) " and substitute " 40a ".
40a. Subventral tufts of siphon double . . . . . sp. indet.
These tufts with 3 or 4 branches . . . . . *tritaeniorhynchus* (p. 201).
43. *Note.*—Delete " *perfidiosus* (p. 227) " and substitute " *perfuscus* ".

Acknowledgements.

Much use has been made of the collection of mosquitoes in the entomological collection at the Agricultural Research Institute, Wad Medani. The collecting of mosquitoes was begun in 1903 by Sir Andrew Balfour. Mr. H. H. King collected very widely in the southern Sudan from 1909 to 1913 and recorded the distribution of many species. Later Mr. W. Ruttledge continued the work, finding additional species and adding many records of distribution. Their specimens and records have been of the greatest value. The author is very much indebted to members of the Sudan Medical Service and many others who have sent specimens for identification from all parts of the country. In many cases names of collectors are shown in the paragraphs on distribution. I am also grateful to Professor H. H. Salem of the Faculty of the Medicine at Alexandria

for sending adult specimens of *Culex arbieeni*. Dr. Abbott's discoveries in Darfur have been mentioned in the introduction.

References.

Balfour, A., 1904, *First Report of the Wellcome Research Laboratories. . . . Khartoum.* Sudan Government.

——, 1908, *Third Report of the Welcome Research Laboratories.* Sudan Government.

Balfour-Browne, J., 1943, On the Apioninae (Coleoptera : Curculionidae) of the Jebel Marra, Darfur Province, Anglo-Egyptian Sudan. *Ann. Mag. nat. Hist.* **71** : 766–72.

Barraud, P. J., 1934, Family Culicidae. Tribes Megarhinini and Culicini. *The Fauna of British India, . . . Diptera* **5**.

De Meillon, B., and Pereira, M. de C., 1940, Notes on some Anophelines (Dipt. Culicidae) from Portuguese East Africa. *Moçambique Docum. trim.* no. **23** : 69–83.

—— and Rebêlo, A., 1941, Culicini (Diptera, Nematocera) from the Colony of Moçambique. *Moçambique Docum. trim.* no. **27** : 69–77.

Edwards, F. W., 1913, Further notes on African Culicidae. *Bull. ent. Res.* **4** : 47–59.

——, 1920, Mosquito notes. *Bull. ent. Res.* **10** : 129–37.

——, 1930, Notes on exotic Chaoborinae with description of new species (Diptera, Culicidae). *Ann. Mag. nat. Hist.* (10) **6** : 528–40.

——, 1941, *Mosquitoes of the Ethiopian Region III.—Culicine adults and pupae.* British Museum (Natural History).

Evans, A. M., 1938, *Mosquitoes of the Ethiopian Region II.—Anophelini adults and early stages.* British Museum (Natural History).

Hopkins, G. H. E., 1936, *Mosquitoes of the Ethiopian Region I.—Larval bionomics of mosquitoes and taxonomy of Culicine larvae.* British Museum (Natural History).

——, 1941, Mosquitoes of the Ethiopian Region; Notes and corrections. *Bull. ent. Res.* **33** : 175–9.

Jobling, B., 1938, On two subspecies of *Culex pipiens* L. (Diptera). *Trans. R. ent. Soc. Lond.* **87** : 193–216.

Lewis, D. J., 1942a, A northern record of *Anopheles gambiae* Giles (Dipt., Culicidae). *Proc. R. ent. Soc. Lond.* (B) **11** : 141–2.

——, 1942b, The early stages of *Aëdes taylori* Edwards and *A. furcifer* Edwards (Dipt., Culicidae). *Proc. R. ent. Soc. Lond.* (B) **11** : 153–4.

——, 1943a, Mosquitoes in relation to yellow fever in the Nuba Mountains, Anglo-Egyptian Sudan. *Ann. trop. Med. & Parasit.* **37** : 65–76.

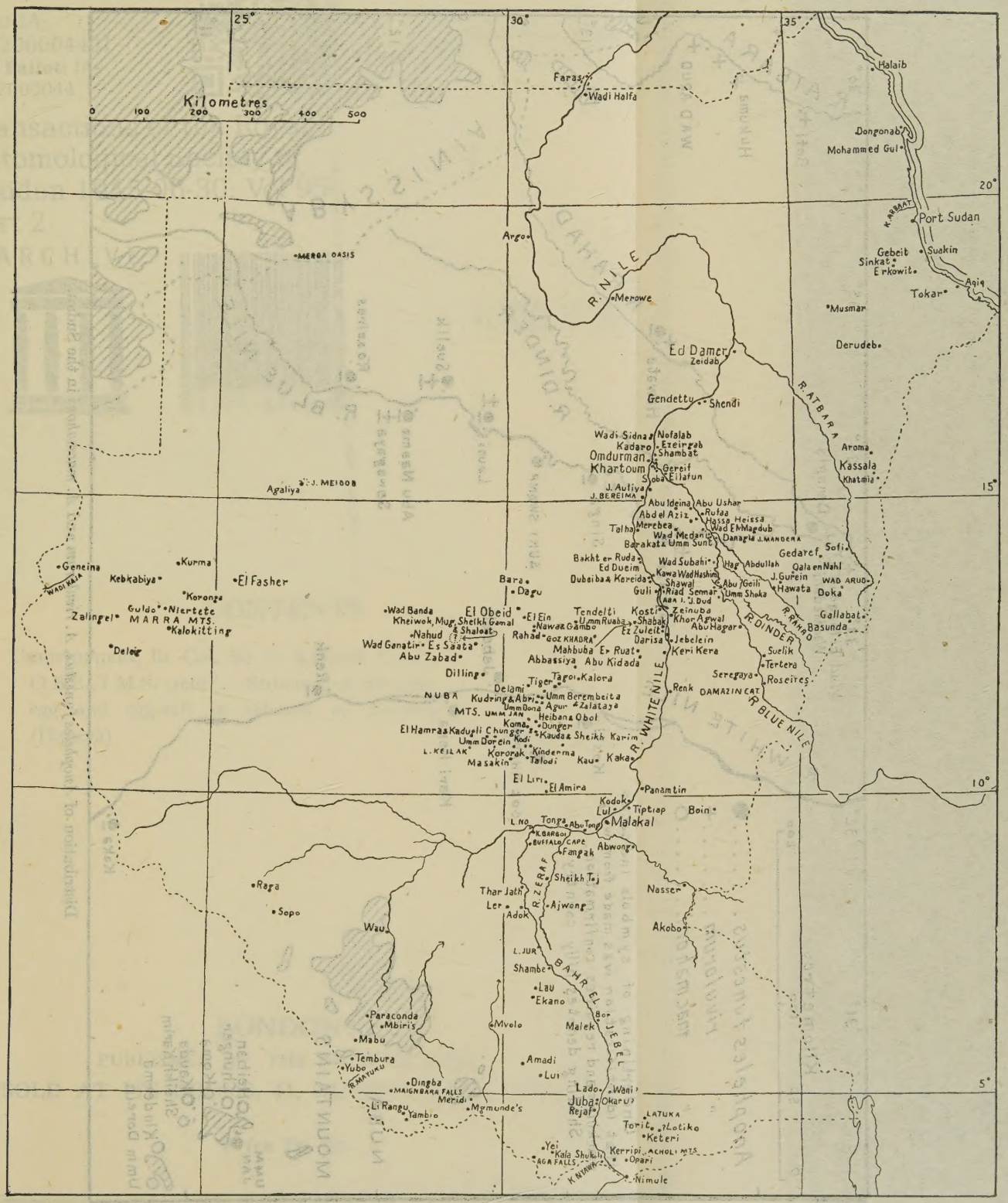
——, 1943b, The Culicine mosquitoes of Eritrea. *Bull. ent. Res.* **34** : 279–85.

——, 1944a, A new subspecies of *Aëdes leesoni* Edwards (Dipt., Culicidae) from the Sudan. *Proc. R. ent. Soc. Lond.* (B) **13** : 27–9.

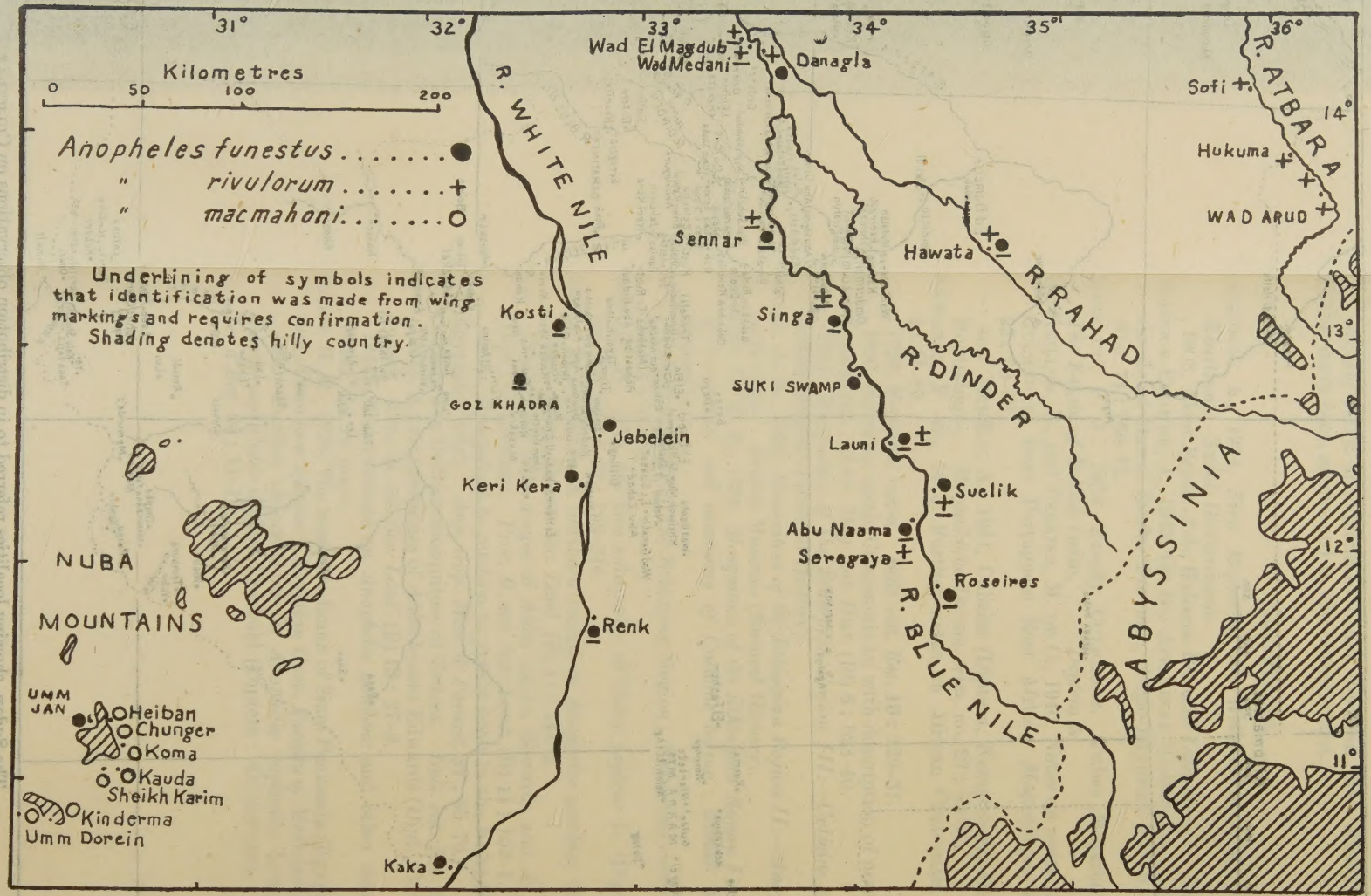
——, 1944b, Observations on *Anopheles gambiae* and other mosquitoes at Wadi Halfa. *In the press.*

Salem, H. H., 1938, The mosquito fauna of Sinai Peninsula (Egypt), with a description of two new species. *Egyptian Univ. Faculty of Medicine Publ. no.* **16**.

——, 1940, Further observations on *Anopheles rupicolus* Lewis, *Culex arbieeni* Salem, and *Culex theileri* Theobald (Diptera : Culicidae). *Bull. Soc. Fouad 1er d'Ent.* **24** : 11–16.



The Sudan, showing localities referred to in distribution observations on CULICIDAE.



Distribution of *Anopheles funestus*, *A. rivulorum* and *A. macmahoni* in the Sudan.